Search for SUSY in Like-Sign Di-Electron Channel with DØ in Tevatron Run 2

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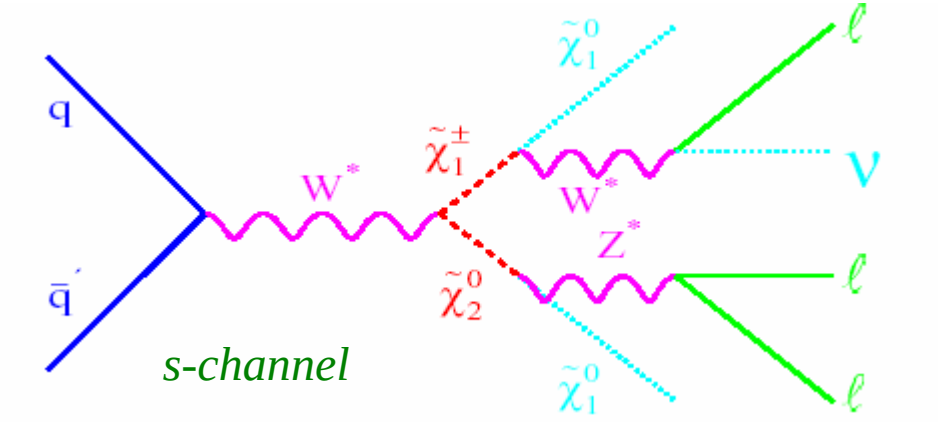
Outline:

- The mSUGRA Model
- Upgraded Tevatron & DØ Detector for Run 2
- Signal and Backgrounds MC Studies
- Preliminary Data on Electron Detection
- Summary

The Minimal Super Gravity Model

- The mSUGRA model is completely defined by only five free parameters: m_0, $m_{1/2}$, tan(β), A_0, sign(μ)
- Assuming R-parity conservation → pair production + LSP which escapes detection.



VERY CLEAN!

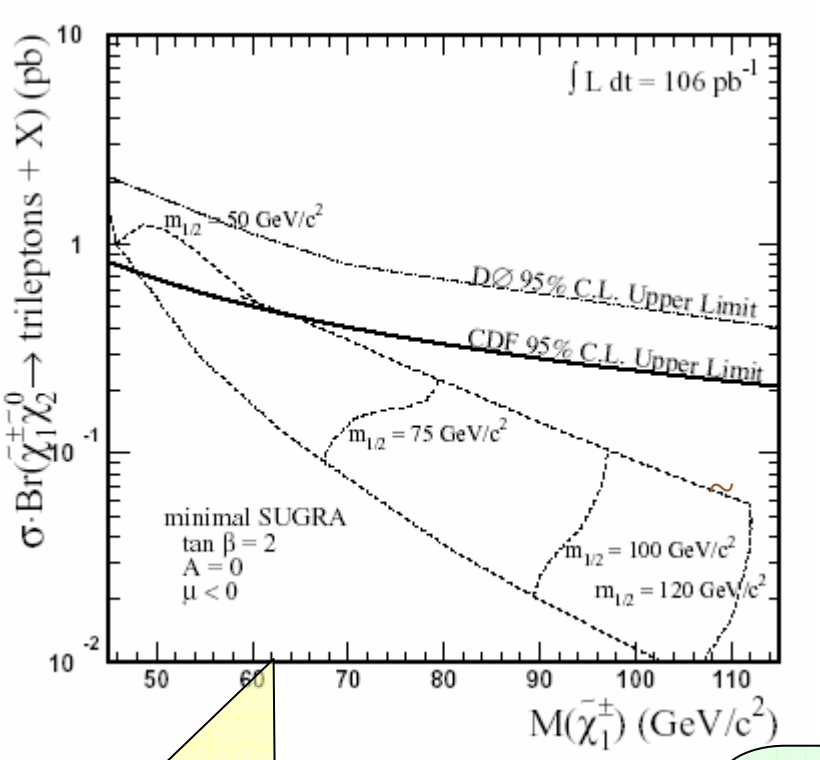
Experimental Signals:

Isolated Trilepton with missing E_T → Inclusive Like Sign Dilepton

Isolated Like-Sign Dilepton with missing E_T

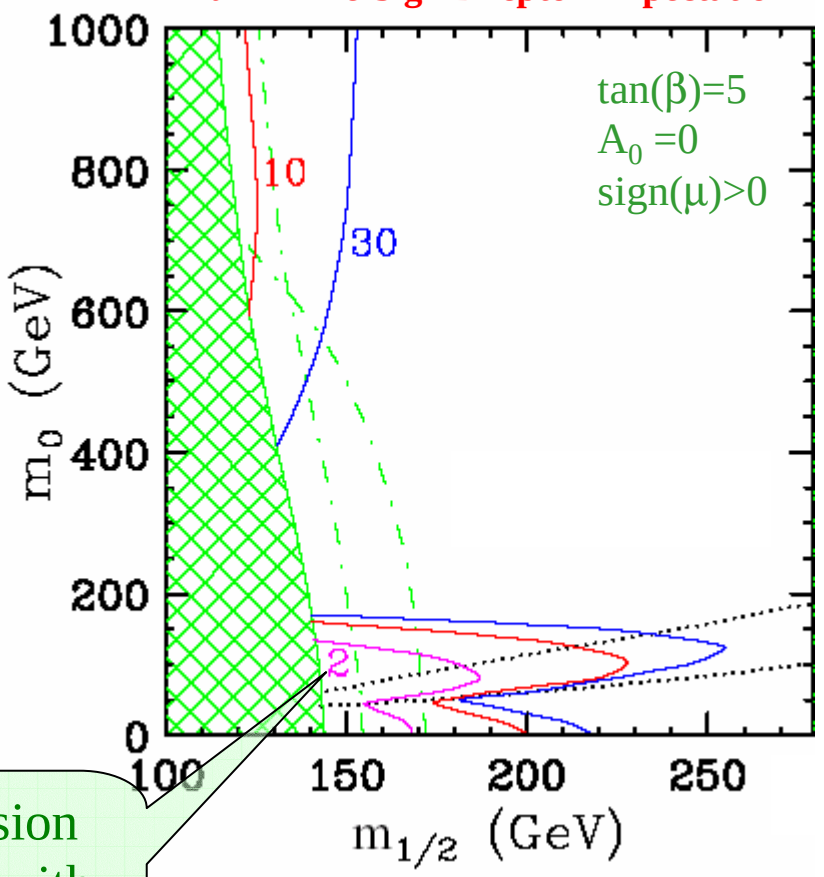
Run1 Search Status & Run2 Expectation

Run 1 Trilepton Result



Best Limit :
$M(\tilde{\chi}_1^{\pm}) > 62 GeV/c^2$

Run 2 Like-Sign Dilepton Expectation



3σ exclusion contours with 2,10,30 fb^{-1} Lum.

K. Matchev and D. Pierce, Phy.Rev.D60, 075004

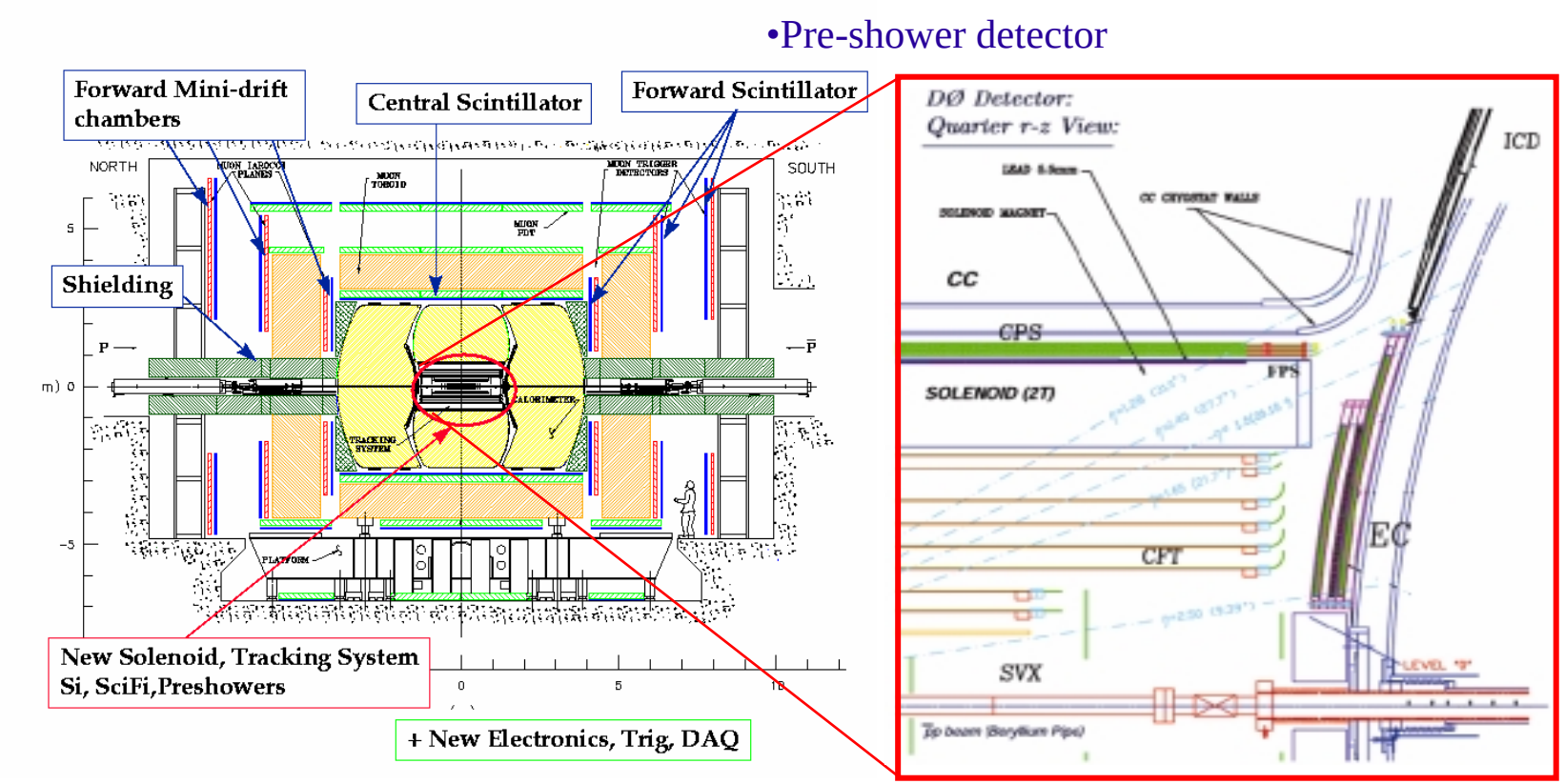
Upgraded Tevatron and DØ Detector

Tevatron upgrade:

- Increased energy: 1.8 TeV → 1.96 TeV
- Expected Lum.: 0.1 fb^{-1} → 2 fb^{-1} → 15 fb^{-1}
  (Run1) (Run2a) (Run2b)

DØ Detector Upgrade for Run 2:

- Inner tracking system (Silicon and Fiber Tracker) with 2T inner magnetic field(Charge measurement!)
- Upgraded muon system (new end cap detectors)
- Pre-shower detector



Signal and Backgrounds

One representative set of mSUGRA parameters:

(m_0,$m_{1/2}$,tan(β),A_0,sign(μ)) = (100, 180, 5, 0, positive)

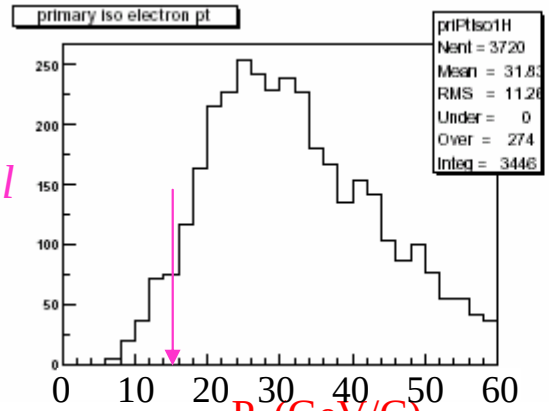
MC events simulated: 5000 (select events with N(e) > 1):

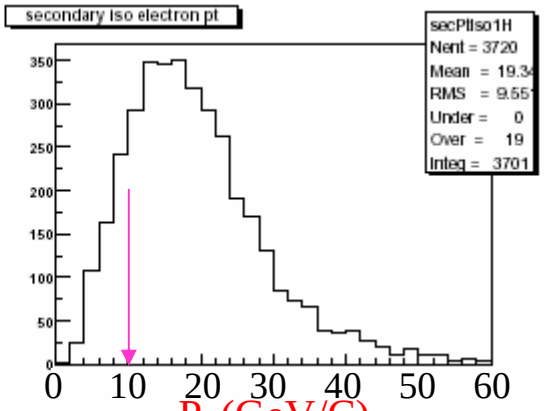
Major backgrounds:

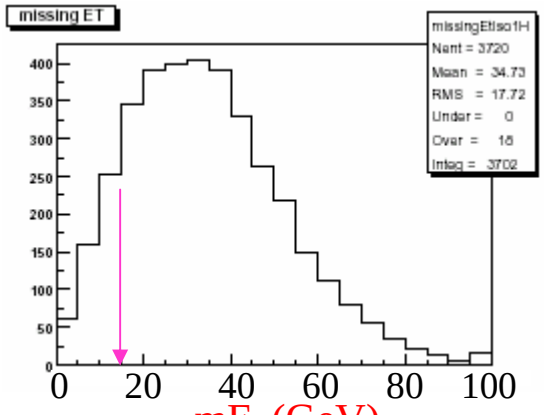
$W^{\pm}Z^0/W^+W^-/Z^0Z^0$, Drell-Yan,

$t\bar{t}$, $b\bar{b}$ /$c\bar{c}$, and W+Jets

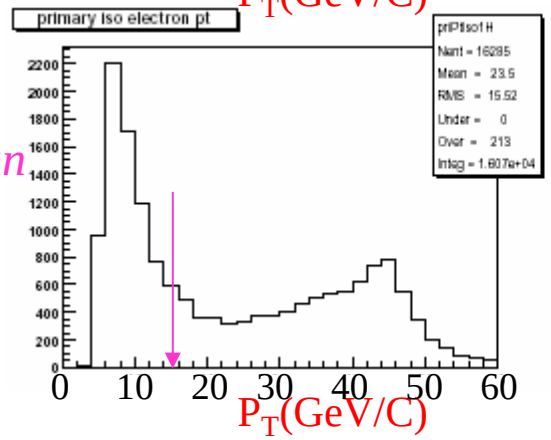
Signal

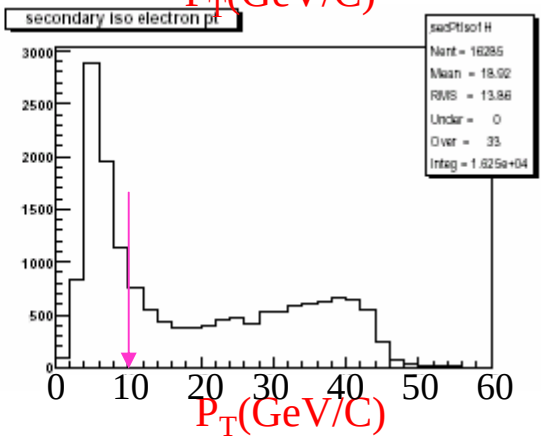


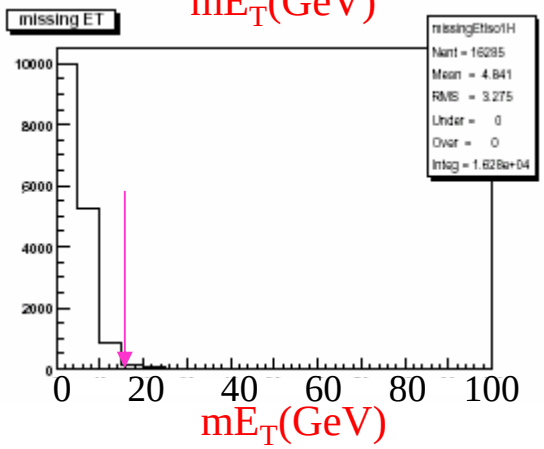




Drell-Yan







Signal and Backgrounds(cont')

Two final state samples are selected:

Like-Sign Di-electron sample:

2 isolated electrons, $P_T(e_1)$>15GeV, $P_T(e_2)$>10GeV, missing E_T >15GeV. The 2 electrons both match with isolated tracks, require 0.5<E_T/P_T<2.0 and are like sign. $|M_{ee}-M_Z|$<15GeV

Tri-electron sample:

3 isolated electrons, $P_T(e_1)$>15GeV, $P_T(e_2)$>10GeV and $P_T(e_3)$>5GeV. All the electrons match with isolated tracks and require 0.5<E_T/P_T<2.0. $|M_{ee}-M_Z|$ <15GeV

Acceptance (Geometry + Kinematic + Reconstruction) for Signals are:

Tri-electron: 10 %

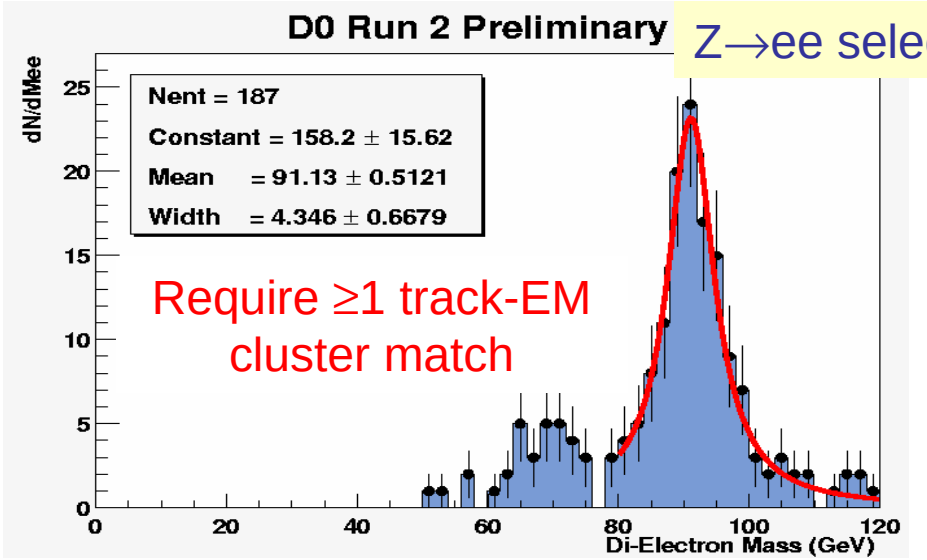
Like-Sign Di-electron: 6 %

> 50% enhancement in signal acceptance!

Process	Number of MC	Accpt(eee)	Accpt(LS ee)
WZ	*125,000*	*1.6e-4*	*7.2e-4*
Drell-Yan	*50,500*	*1.98e-5*	*<1.98e-5*
ttbar	*440,000*	*<2.3e-6*	*<2.3e-6*
W+Jets	*284,500*	*<3.5e-6*	*<3.5e-6*

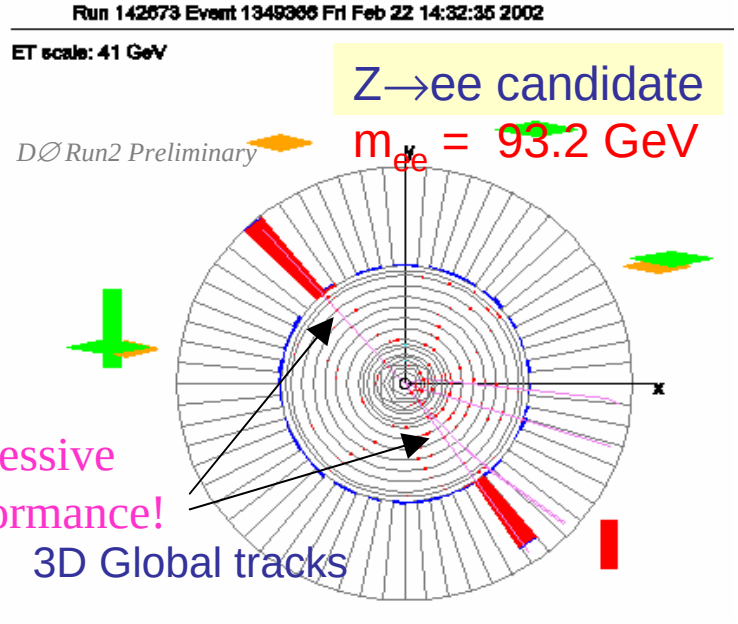
All the backgrounds are strongly suppressed!

Run 2 DØ Detector Performance



Z→ee selection

Require ≥1 track-EM cluster match

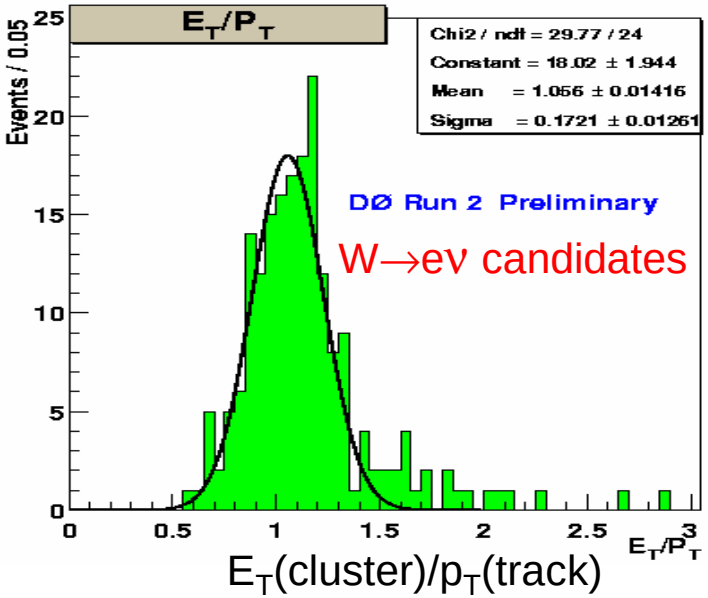


Z→ee candidate

m_{ee} = 93.2 GeV

Impressive Performance!

3D Global tracks

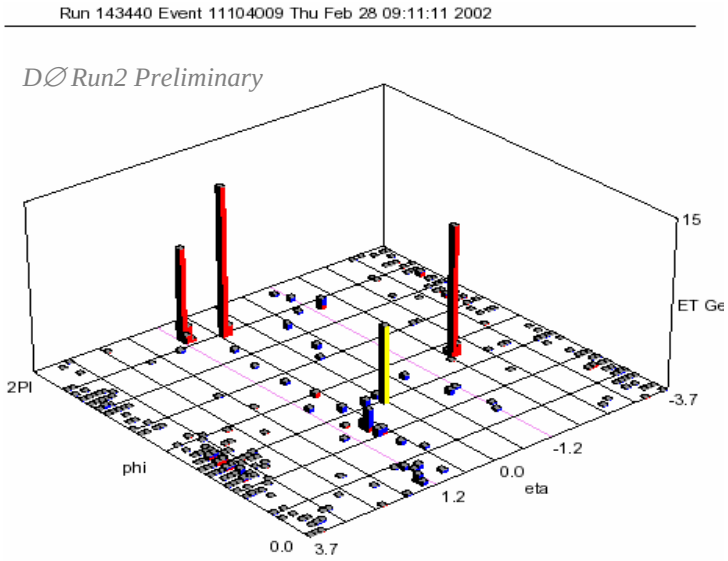


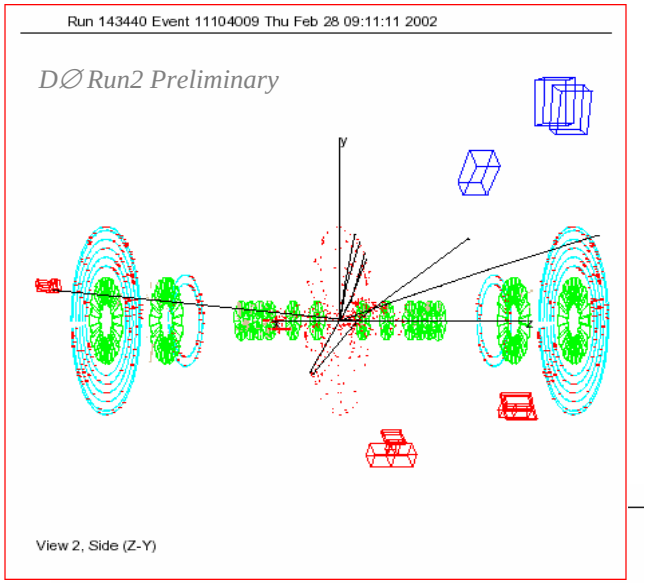
For Inner Tracking System:

Silicon Tracker: 100% commissioned

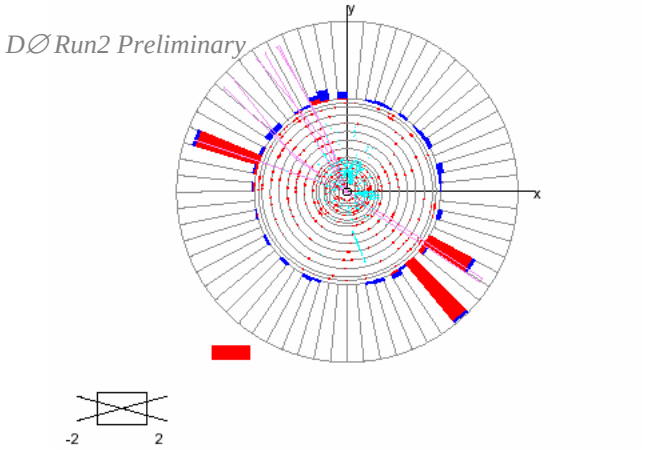
Fiber Tracker: 100% instrumented by Mid April

Tri-Electron Event

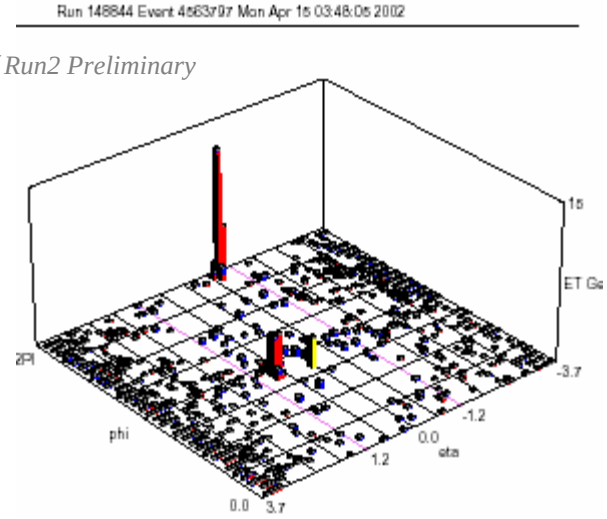


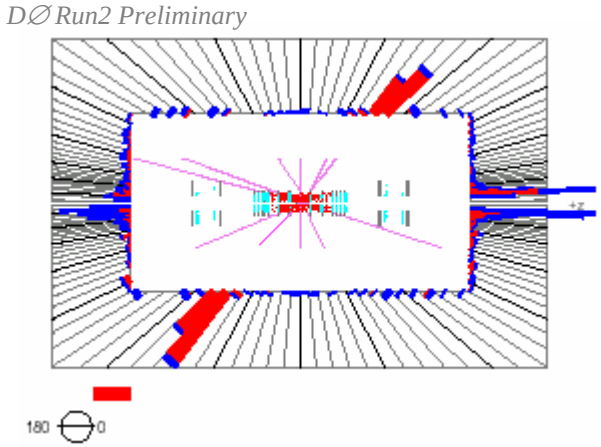


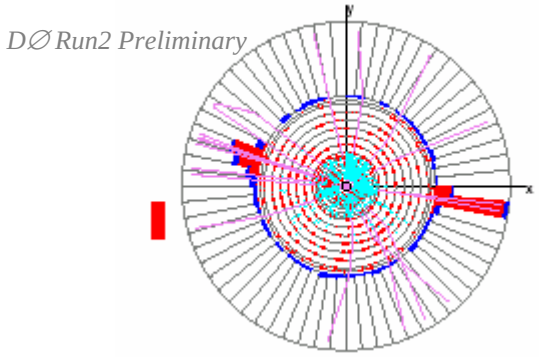
e1	e2	e3
E_T = 17.9 GeV p_T = 0.52 GeV η = 0.43 φ = 5.42 Charge = +1	E_T = 13.9 GeV p_T = 10.9 GeV η = -1.94 φ = 2.80 Charge = +1	E_T = 13.2 GeV p_T = 15.1 GeV η = 1.06 φ = 5.72 Charge = -1
m_{e1e2} = 55.7	m_{e1e3} = 10.8	m_{e2e3} = 63.5
m_{e1e2e3} = 85.2 GeV/c^2	ME_T =10.7 GeV	



Like-Sign Di-Electron Event







e1	e2
E_T = 23.2 GeV η = -0.81 φ = 6.14 f_{ISO}= 0.046, f_{EM}= 0.96	E_T = 16.2 GeV η = 0.76 φ = 2.84 f_{ISO}= 0.027, f_{EM}= 0.99
Global Track 1	Global Track 2
P_T = 6.89 GeV η = -0.77 φ = 6.15 charge= +1	P_T = 5.23 GeV η = 0.71 φ = 2.80 charge=+1
M(ee)=51.3GeV,mE_T=2.48GeV	

Summary

• Upgraded DØ detector for Run 2 physics program is ready.

• Tri-Electron and Like Sign Di-Electron final states provide one of the cleanest experimental signature of the mSUGRA model. With 2T magnetic field and the precision inner tracker, DØ can detect the Like Sign Di-Electron events, which significantly enhances the SUSY signal acceptance by more than 50% while the backgrounds are strongly suppressed.

• It will be a very exciting future, with 20 times increase in integrated luminosity, DØ experiment is capable to explore much more parameter space in the mSUGRA model than in Run 1.